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# REA PROPOSED SPECIFICATION FOR

# VOICE FREQUENCY LOADING COILS



Telephone Engineering Division
Rural Electrification Administration
U.S. Department of Agriculture
Washington 25, D. C.

RURAL ELECTRIFICATION ADMINISTRATION
TELEPHONE ENGINEERING DIVISION

PROPOSED SPECIFICATION

FOR

VOICE FREQUENCY LOADING COILS

1. GENERAL

1.1 The specification for voice frequency loading coils establishes the physical and performance requirements for voice frequency loading coils to be used with exchange cable for exchange and toll use on telephone systems of REA Borrowers.

1.2 The loading coil code number, nominal inductances and maximum dimensions covered in this specification are listed in the following Table I:

TABLE I

| Type of Loading Coil | Nominal Inductance | Over-All Maximum Coil Dimensions - Inches | |
|---|---|---|---|
| | | Diam. | Height |
| Type 32 | 88 milli-henry | 1.25 | 0.63 |
| Type 38 | 44 milli-henry | 1.25 | 0.63 |
| Type 51 | 44 milli-henry | 1.06 | 0.43 |
| Type 88-50 (Side Ckt. | 88 milli-henry | 1.25 | 0.63 |
| (Phantom Ckt. | 50 milli-henry | 1.15 | 0.50 |

1.3 All loading coils shall be mounted in loading coil cases as specified in Paragraphs 7 to 7.72.

2. CORES

2.1 The loading coils shall be wound on torodial-shaped cores.

2.2 The cores shall be made of powdered magnetic material.

2.3 The core shall be finished in such a way as to be impervious to moisture when test by the method outlined in ASTM Designation D116-44, Sections 32 to 34.

2.4 The core shall have a dielectric strength of 1250 volts rms at 60 cps. The core dielectric strength shall be tested by placing the core between two moist felt pads with the testing electrodes placed over the pads.

3. COIL WINDINGS

3.1 The winding of the type 32, 38, and 51 loading coils shall consist of two windings as shown in Figure 1. The two windings shall not overlap.

3.2 The windings for the 88-50 phantom group loading coils shall be arranged as shown in Figure 2.

3.3 The windings shall be uniformly distributed over the core and there shall be no exposed core. The term uniformly distributed is defined as meaning that the winding shall not be scramble wound and that the wire shall be laid uniformly along the circumference of the inside diameter of the core with the wire laying around the outside diameter of the core in as uniform arrangement as is practical.

3.4 The direction of the windings of each half of the coil shall be such that the coils will be series-aiding when leads 2 and 3 are connected together.

3.5 The windings shall be wound so as to meet the inductance and resistance requirements specified in Paragraphs 4.1.

3.6 The gauge of the wire and the number of turns of each winding shall be such as to produce the required inductance and meet the effective resistance limits.

3.7 The wire used for winding the loading coils shall be insulated with Heavy Formex Insulation or an insulating material which has electrical and mechanical properties equivalent to Heavy Formex Insulation. An insulating material meeting the requirements specified in Appendix I to this specification shall be considered as equivalent to Heavy Formex Insulation.

4. ELECTRICAL REQUIREMENTS

4.1 The loading coils shall meet the electrical performance requirements specified in the following Table 2, when by methods specified in Paragraphs 5.11 to 5.24.

TABLE 2

| Electrical Characteristics | Type of Coil | | | | |
|---|---|---|---|---|---|
| | 32 | 38 | 51 | 88-50 | |
| | | | | Side | PH |
| Nominal Inductance (mh) | 89 | 44 | 44 | 88.65 | 50.15 |
| Inductance Tolerance, Percent of Nominal | 3 | 3 | 3 | 2.0 | 2.0 |
| Max. Inductance Unbalance, Percent of Nominal (Between Windings) | 0.50 | 0.50 | 0.50 | 0.30 | 0.75 |
| Max. Effective Resistance, Ohms | 13.90 | 7.10 | 11.50 | 12.55 | 6.25 |
| Max. D.C. Resistance, Ohms | 9.80 | 5.40 | 8.4 | 9.12 | - |
| Max. D.C. Resistance, Unbalance, Ohms (Between Windings) | 0.2 | 0.1 | 0.1 | 0.20 | - |
| Min. Insulation Resistance (Megohms) | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 |
| Min. Dielectric Strength (Volts r.m.s.) 60 CPS | 500 | 500 | 500 | 500 | 500 |
| Max. Average Cross-Talk Between Coils at 1000 CPS - Coils in Case Connected to Stub (C.U.) | 25 | 25 | 25 | 35 | 35 |
| Max. Cross-Talk Between Coils at 1000 CPS - Coils in Case Connected to Stub (C.U.) | 45 | 45 | 45 | - | - |

5. TESTS

5.1 Inductance shall be measured at 2000 cycles per second with a 2 milliampere a.c. current flowing through the two windings connected in series--aiding at a temperature of 68° Fahrenheit. The inductance shall be measured with a General Radio Company's No.667A inductance bridge with the General Radio Company's No. 1231B Amplifier and Null Detector and No. 1301A Oscillator or an inductance bridge with detector and oscillator having precision and performance characteristics equivalent to the General Radio Company apparatus.

5.2 The effective resistance shall be measured at a frequency of 2000 c.p.s. with a bridge having a $\pm$ 3 percent accuracy. A current of 2 milli-amperes a.c. shall flow through the windings of the loading coil during the test. The current measuring equipment shall have an accuracy of $\pm$ 2.5 percent.

5.3 The inductance unbalance between windings shall be measured in an a.c. bridge circuit similar to the circuit shown in Figure 3. The bridge shall be capable of measuring inductance unbalance of 1 percent between two windings of loading coil with an accuracy of $\pm$ 0.1 percent. The measurement shall be made at 1000 c.p.s. with a current of 2 milli-amperes a.c. through the coil windings.

5.4 The d.c. resistance of the loading coils shall be measured in a bridge similar to the one shown in Figure 4 and the circuit shall have an accuracy of $\pm$ (0.5% + 0.05 ohm).

A current of not more than 10 milli-amperes d.c. shall flow through the coil windings during the test.

5.5 The d.c. resistance unbalance test between the two windings of a loading coil shall be made with a bridge circuit similar to the one shown in Figure 5. The bridge shall have an accuracy of ± (.05% ± 0.05 ohms).

5.6 The insulation resistance shall be measured in a circuit with an accuracy of ± 10 percent, with an electrification of not more than 10 minutes and with a voltage between 100 and 125 volts. The measurement shall be made with a bridge having the precision and performance characteristics equivalent of the General Radio Type 544-B Megohm Bridge.

5.7 The dielectric strength shall be tested in a circuit consisting of a power source connected to a pair of test terminals through a series resistance and with a voltmeter connected across the test terminals. The common junction of power source, voltmeter and the test terminal shall be grounded.

The series resistance shall have a value of approximately 1 ohm per volt of test voltage and shall be capable of carrying 1 ampere. The voltmeter shall be capable of reaching full scale within the specified test period and shall be capable of measuring the test voltage with an accuracy of ± 5 percent. The power source including all auxiliary apparatus shall have a current rating of at least 1/2 ampere at the test voltage. The frequency shall be 60 cycles per second and the form of the voltage wave as measured at the open test terminals shall

be such that the ratio of the peak value to the root mean square value shall not differ from 1.414 by more than 10 percent. The test voltage shall be held to the specified value -0 +5 percent. The test voltage shall be applied for a period of not less than 1/4 second.

The apparatus under test shall be considered to have failed if the voltmeter fails to indicate, or if the voltmeter indicates less than the test voltage during the test.

5.8 The finished loading coils shall meet crosstalk requirements specified for two different conditions. The first condition is for loading coils not assembled into loading coil mounting cases, while the second condition pertains to crosstalk measured at the open end of a cable stub after the loading coils have been enclosed in a loading coil case and connected to the stub. The crosstalk performance shall be measured at 1,000 cycles per second.

5.81 For the purpose of this specification the crosstalk limit requirements shall be expressed in crosstalk units (CU). The number of crosstalk units is defined as one million times the square root of the ratio of the power in the disturbed circuit to the power in the disturbing circuit. Expressed mathematically

$$CU = 10^6 \sqrt{\frac{P_2}{P_1}}$$

where $P_1$ is the power in the

disturbing circuit and $P_2$ is the power in the disturbed circuit. When the impedance of the two circuits is the same at the test frequency, the equation may be expressed as a ratio of the voltage: $CU = 10^6 \frac{E_2}{E_1}$.

Crosstalk measurements shall be made between adjacent loading coils types 32, 38, and 51 by the method given in Figure 6. The coils shall be separated by a 1/8" thick non-metallic spacer.

5.82 The side to side crosstalk for the 88-50 phantom group side circuit loading coils mounted in a loading coil case shall be measured through the cable stub using a circuit similar to that shown in Figure 7.

5.83 The phantom to side circuit crosstalk for the 88-50 phantom group loading coils mounted in a loading coil case shall be measured through the cable stubs using a circuit similar to that shown in Figure 8. The phantom circuit shall be energized and the crosstalk produced in the side circuits measured.

6. LOADING COIL IMPREGNATION

6.1 All types of loading coils specified in this specification shall be vacuum impregnated with General Electric Varnish No. 1678 or No. 1679, Harvel 612C Insulating Varnish or an insulating varnish having electrical, physical and chemical properties equivalent to those of the varnishes listed. An insulating varnish with the electrical, physical and chemical properties

applied in the manner described in Appendix II to this specification shall be considered as equivalent.

## 7. LOADING COIL CASES

7.1 The loading coils shall be enclosed in loading coil cases which meet the requirements given in this section of the specification.

7.2 The loading coil case codes, dimensions, capacities and methods of mounting are specified in Table 3.

TABLE 3

| Type of Loading Coil Case | Type of Loading Coil | Capacity No. of Coils | Maximum Dimensions | Method of Mounting |
|---|---|---|---|---|
| 2 A | 32 or 38 | 1 | 1-1/2" OD x 11/16" high | In Cable Splice |
| 4A or 4AA | 32 or 38 | 5 to 15 | No Maximum Limit | Suspended from Cable |
| 4B or 4BA | 32 or 38 | 16 to 26 | No Maximum Limit | do |
| 7 A | 32 or 38 | 6 | 1-7/16 OD x 5-1/4" long | In Cable Splice |
| 8 A | 51 | 6 | 1-1/[illegible]" OD x 4-1/4" long | do |
| 8 B | 51 | 11 | 1-1/4" OD x 7-1/4" long | do |
| 8 C | 51 | 16 | 1-1/4" OD x 10-1/4" long | do |
| 8 D | 51 | 20 | 1-1/4" OD x 12-3/4" long | do |
| 08A or 08AA | 88-50 | 7 to 12 | No Maximum Limit | Pole or Manhole |
| 08A or 08BA | 88-50 | 13 to 18 | No Maximum Limit | do |

NOTE: Loading coil cases 4AA, 4BA, 08AA and 08BA shall be used with plastic-jacketed plastic-insulated cable, loading coil cases 4A, 08A and 08B shall be used with paper or pulp-insulated cable. (Refer to Paragraph 7.4.)

7.3 The type 4 loading coil case shall be designed for suspension mounting from the aerial cable strand. A cable stub shall be provided for connecting the loading coils contained within the loading coil case, to the cable pairs in the cable splice.

7.31 The housing for the loading coil case shall be made of material which will have a weather resistance comparable to that of lead. The housing shall be so constructed that it will be impervious to moisture when tested in accordance with specifications stated in Paragraph 7.32.

7.32 The loading coil case complete with loading coils and cable stub shall be tested for seal against moisture penetration. The end of the sealed cable stub shall be fitted with a pressure testing nozzle and the loading coil case shall be filled with a dry inert gas or dry air to a pressure of fifteen (15) pounds. The temperature of the unit shall be held constant for a period of 24 hours. The pressure shall not drop more than one-tenth (.1) pound in 24 hours. The pressure gauge shall be of the Bourdon Tube type having a diameter not less than four and one-half ($4\frac{1}{2}$) inches. This test shall be applied to every loading coil case.

7.33 The loading coil case shall be mechanically strong enough so that when the housing is supported at each end and a fifty (50) pound weight is suspended from the center of the housing as shown in Figure 9, there shall be not more than 1/16" deflection at L/2 distance from the end

of case. This test shall apply to loading coil cases which are one foot or more in length.

The cable stub shall be securely fastened to the housing and shall be capable of supporting the weight of the loading coil case complete with loading coils plus an additional weight of 50 pounds when suspended in a vertical position. This test shall be applied to pilot production models to prove the design.

7.34 Should the loading coil case housing be made of a non-metallic material, a metallic shielding of 8 mil aluminum or 4 mil copper shall be placed around the loading coils. The shield shall be electrically connected to the shielding of the cable stub.

7.35 The loading coils shall be assembled in groups of five. The loading coil groups shall be mounted on a non-metallic dowel and separated with insulated spacers as specified in Paragraph 7.51. The leads to the loading coils shall be anchored to the spacers between coils.

7.36 The cable stub may be either a lead sheathed, pulp or paper insulated cable; a plastic sheathed, pulp or paper insulated cable with a continuous moisture proof metallic shield or a plastic jacketed plastic insulated cable. The conductors shall be 24 gauge for cable stubs used with loading coil cases types 4, and 08.

7.37 Two cable pairs are required to provide the "in" and "out" lead to individual loading coils. The two pairs form a "quad". Five quads shall be grouped and defined as a

"quint". The method of marking the quints shall be in accordance with either one of the two schemes shown in Table 4.

7.38 The insulation of the cable stub shall have a dielectric strength of 3000 volts 60 cycle a.c. between conductors and between the conductors and the sheath.

7.4 Loading coil cases types 4AA, and 4BA are for use with plastic-jacketed plastic-insulated cable and provision shall be made to prevent moisture from migrating through the cable stub into the loading coil case. A means shall be provided at the cable end of the stub for connecting the shield in the stub to the shield in the cable.

7.5 Type 7 and 8 loading coil cases shall be designed for mounting in a cable splice. The loading coils shall be mounted on a nonmagnetic dowel rod separated by spacers described in Paragraph 7.51. The assembly is then enclosed in a cylindrical sleeve. The sleeve shall be arranged so as to completely enclose the loading coils and serve as a moistureproof barrier. The leads "in" and "out" shall be arranged in such manner as to preserve the moisture barrier. The edge of the loading coil case shall be rounded to prevent damage to the cable conductor insulation.

7.51 The material used for fabricating the coil separator shall not cause an increase in the effective resistance or inductance of the loading coils over that measured

Table 4

<table>
<tr><td colspan="4">Pulp, paper or plastic insulated stub cable for type<br>4-loading coil case</td></tr>
<tr><td rowspan="2">Make up</td><td>Type 4A case</td><td>Type 4B case</td><td rowspan="2">Notes</td></tr>
<tr><td>15 quads 24 a.w.g.</td><td>30 quads 24 a. w. g.</td></tr>
<tr><td>Arrange-ment of core</td><td>Core is made up of five quad units (quints)<br>3 Quints<br>Color quint binders / Quint count / Quad count<br>O / 1 / 1-5<br>G / 2 / 6-10<br>B / 3 / 11-15</td><td>Core is made up of five quad units (quints)<br>6 quints<br>Color quint binders / Quint count / Quad count<br>O / 1 / 1-5<br>G / 2 / 6-10<br>B / 3 / 11-15<br>B / 4 / 16-20<br>B / 5 / 21-25<br>OWK / 6 / 26-30</td><td>1. Letters indicating colors as follows:<br>B - Blue<br>G - Green<br>K - Black<br>O - Orange<br>R - Red<br>W - White</td></tr>
<tr><td>Make up of one quint and coil con-nection</td><td>1st Alternative<br>Quad No. / "In" Ins. / Pr. stain / "Out" Ins. / Pr. stain<br>1 / B/W / / R/W / R<br>2 / B/W / G / R/W / R-G<br>3 / B/W / B / R/W / R-B<br>4 / B/W / O / R/W / R-O<br>5 / B/W / K / R/W / R-K<br>2nd Alternative<br>Quad No. / "In" Ins. / Pr. Binder / "Out" Ins. / Pr. Binder<br>1 / B/W / / R/W / R<br>2 / B/W / G / R/W / R-G<br>3 / B/W / B / R/W / R-B<br>4 / B/W / O / R/W / R-O<br>5 / B/W / K / R/W / R-K</td><td>Same as<br>For Type 24A</td><td>2. Conductors in a quint having white insulation (except "IN" conductors, 1st quad) are stained with colored bands. When one color of stain is shown, these bands are at intervals of from 3 to 4 inches. When two colors of stain are shown the two bands spaced on approximatly 1/2 inch centers and the double bands are at intervals of from 2 to 3 inches.</td></tr>
</table>

under Paragraphs 5.1 and 5.2. The material used for fabricating the separator shall have an initial moisture content of less than one percent measured in the manner specified in ASTM Designation D116-44, Sections 32 to 34. The separator shall serve the additional function of an anchor for the lead wires from the loading coil similar to the method shown in Figure 10.

7.52 The leads "in" to the coil shall be grouped together, bound with adhesive insulating tape and taken out one end of the loading coil case. The leads "out" shall be grouped together, bound with adhesive insulating tape and taken out the opposite end of the loading case.

7.53 All leads shall be approximately 18" long and of no. 22 gauge wire. The insulation shall be color coded in accordance with that shown for type 4 loading coil cases in Table 4.

7.6 The Type 2A loading coil case shall be designed for mounting individual loading coils inside of a cable splice. The 2A loading case shall consist of a non-metallic moisture-resistant container fitted with two cotton tapes for binding the case to the cable core in the splice. This loading coil case shall completely enclose the loading coil and shall provide a means for anchoring coil leads.

7.7 The 08A and 08B series of loading coil cases are designed for enclosing the 88-50 type loading coils. The case housing and cable stub shall meet the requirements given in Paragraphs

7.31 to 7.32, 7.34, 7.36 to 7.38. The case shall be equipped with brackets for use in pole mounting.

7.71 The 08AA and 08BA loading coil cases shall be arranged so that moisture shall not enter the loading coil case by migrating through the cable stub. This arrangement provides for the use of this loading case with plastic-jacketed plastic-insulated cable.

7.72 The cable stub shall use 19 gauge copper conductors arranged in quads as shown in Table 5.

8. QUANTITY CONTROL

8.1 The manufacturer shall employ a method of inspection which will insure a uniform product that meets the electrical performance and mechanical requirements specified in this specification.

Table 5
Stub Cable for 08A, 08B, 08AA and 08BA
Loading Coil Cases



LOADING COIL CASE - ARRANGEMENT OF CORE

08A and 08AA

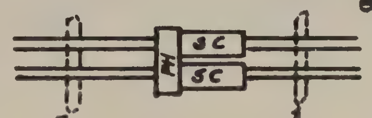
| Center | 1st layer 4 quads | | | 2nd layer 8 quads | | | 3rd layer 13 quads | | |
|---|---|---|---|---|---|---|---|---|---|
| | Insulation color | Quad binder | Quad count | Insulation color | Quad binder | Quad count | Insulation color | Quad binder | Quad count |
| Filler | OR | (W) | 21 | OR | (W) | 13 | OR | (W) | 1 |
| | OR | (R) | 22 | OR | (R) | 14 | OR | (R) | 2 |
| | BW | (W) | 23 | BW | (W) | 15 | | Filler | |
| | BW | (BK) | 24 | BW | (R) | 16 | BW | (W) | 3 |
| | | | | BW | (W) | 17 | BW | (R) | 4 |
| | | | | BW | (RK) | 18 | BW | (W) | 5 |
| | | | | BW | (W) | 19 | BW | (RK) | 6 |
| | | | | BW | (R) | 20 | | Filler | |
| | | | | | | | BW | (W) | 7 |
| | | | | | | | BW | (R) | 8 |
| | | | | | | | | Filler | |
| | | | | | | | BW | (W) | 9 |
| | | | | | | | BW | (R) | 10 |
| | | | | | | | BW | (W) | 11 |
| | | | | | | | BW | (RK) | 12 |
| | | | | | | | | Filler | |

Paper wrapping

PH CKT End

Side CKT end

Quads 1,3,5 etc.



Quads 2,4,6 etc.

Quad binder (W)

Quad binder (R RK)

08B and 08BA

| Center | 1st layer 6 quads | | | 2nd layer 12 quads | | | 3rd layer 18 quads | | |
|---|---|---|---|---|---|---|---|---|---|
| | Insulation color | Quad binder | Quad count | Insulation color | Quad binder | Quad count | Insulation color | Quad binder | Quad count |
| 2 Filler | OR | (W) | 31 | OR | (W) | 19 | OR | (W) | 1 |
| | OR | (R) | 32 | OR | (R) | 20 | OR | (R) | 2 |
| | BW | (W) | 33 | BW | (W) | 21 | BW | (W) | 3 |
| | BW | (R) | 34 | BW | (R) | 22 | BW | (R) | 4 |
| | BW | (W) | 35 | BW | (W) | 23 | BW | (W) | 5 |
| | BW | (RK) | 36 | BW | (RK) | 24 | BW | (RK) | 6 |
| | | | | BW | (W) | 25 | BW | (W) | 7 |
| | | | | BW | (R) | 26 | BW | (R) | 8 |
| | | | | BW | (W) | 27 | BW | (W) | 9 |
| | | | | BW | (R) | 28 | BW | (R) | 10 |
| | | | | BW | (W) | 29 | BW | (W) | 11 |
| | | | | BW | (RK) | 30 | BW | (RK) | 12 |
| | | | | | | | BW | (W) | 13 |
| | | | | | | | BW | (R) | 14 |
| | | | | | | | BW | (W) | 15 |
| | | | | | | | BW | (R) | 16 |
| | | | | | | | BW | (W) | 17 |
| | | | | | | | BW | (RK) | 18 |

Paper wrappings

## NOTES

LETTERS INDICATE COLORS AS FOLLOWS:

| | |
|---|---|
| B - BLUE | O - ORANGE |
| G - GREEN | R - RED |
| K - BLACK | W - WHITE |

THE TWO COLORS SHOWN FOR CONDUCTOR INSULATION MEAN THAT ONE PAIR HAS PAPER OF ONE COLOR AND THE OTHER PAPER OF THE SECOND COLOR. THE EDGE OF THE CONDUCTOR INSULATION IN THE RED PAIRS AND WHITE PAIRS IN THE SECOND LAYER IS STAINED BLACK.

THE QUAD BINDERS ARE COMPOSED OF NINE COLORED THREADS, SIX OF ONE COLOR AND THREE OF THE OTHER WHERE TWO COLORS ARE SHOWN. FOR FACTORY IDENTIFICATION, A SINGLE THREAD OF CONTRASTING COLOR MAY REPLACE ONE THREAD WHERE ONE COLOR IS SHOWN.

EACH ODD NUMBERED QUAD IN THE QUAD COUNT, ALWAYS AN "IN" QUAD, IS IDENTICAL WITH RESPECT TO PAIR AND QUAD-TWISTS TO THE SUCCEEDING EVEN-NUMBERED QUAD WHICH IS ALWAYS THE "OUT" QUAD FROM THE SAME LOADING UNIT.

ADJACENT COMBINATIONS OF ASSOCIATED "IN" AND "OUT" QUADS TERMINATING DIFFERENT LOADING UNITS HAVE DIFFERENT COMBINATIONS OF PAIR AND QUAD-TWISTS. IN EACH LAYER HAVING A TOTAL OF SIX OR MORE QUADS, THREE DIFFERENT SETS OF QUADS, IN TERMS OF PAIR AND QUAD-TWISTS, ARE USED IN SYSTEMATIC SEQUENCE SO FAR AS PRACTICABLE.

THE QUADS IN ADJACENT LAYERS, HOWEVER, ARE DIFFERENT WITH RESPECT TO PAIR AND QUAD-TWISTS. LIKE TYPES OF QUADS ARE USED IN ALTERNATE LAYERS.

APPENDIX I

to

Specification for Voice Frequency Loading Coils and Loading Coil Cases

1. GENERAL

1.1 Appendix I to the specification for Voice Frequency Loading Coil Cases gives minimum requirements for insulation of wire used to wind loading coils.

1.2 Insulation requirements of Appendix I apply to copper wire having a diameter of .0285 inches or less.

1.3 The wire shall be insulated with a heavy coat of vinyl acetal or a similar material that will meet the performance requirement listed in Paragraphs 2 to 3.12.

2. PHYSICAL PERFORMANCE OF INSULATION

2.1 The insulated wire shall meet the following elongation requirements without rupture of the insulation.

| Bare Wire Dia. - Inch | Elongation, Percent, Min. |
|---|---|
| .0285 - .0201 | 18 |
| .0179 - .0025 | 15 |

The test section of insulated wire shall be about 10 inches in length and elongation shall be made at a rate of not less than 12 inches per minute. Specimen shall be prepared as specified in Paragraph 2.21. Tests shall be made at a temperature of approximately 68 degrees Fahrenheit.

2.2 The insulated wire shall meet a snap elongation test in which a 10 inch test section is jerked to the breaking point at a rate of 12 to 16 feet per second without showing cracks. The

test shall be made in accordance with Paragraphs 2.21 and 2.22. The test shall be made at a temperature of approximately 68 degrees Fahrenheit.

2.21 The test specimens shall consist of three 2-foot lengths of the wire. Ten inches of each specimen shall be the active test length.

2.22 The test specimen shall be secured in the snap-elongation tester and the tests operated so as to stretch the wire to the breaking point of the copper. The specimen shall then be examined for cracking and "tubing of the insulation." Cracks which extend entirely around the circumference of the wire shall be considered "tubing." If any cracking or "tubing" takes place anywhere on the specimen except within a distance of three wire diameters on each side of the point where the wire breaks, the insulation shall be considered as having failed. Two more such tests shall be made on the remaining two specimens. If none of the specimens fail, the wire shall be considered as having good snap-elongation resistance. Failure of the three specimens shall constitute failure of the product.

2.3 The flexibility of the insulation shall be tested by the method specified in Paragraph 2.31 and the flexibility of the insulation shall meet the requirements given in Paragraph 2.32.

2.31 The test specimen shall be not less than two feet in length. The test specimen shall be stretched 25 percent by straight elongation or to the breaking point of the

copper should this be less than 25 percent. Ten turns of the stretched wire shall then be wound on a mandrel having a diameter three times the wire diameter with adjacent turns touching at a rate of 60 r.p.m. The test shall be performed at a temperature of 60 to 80 degrees Fahrenheit.

2.32 The specimen formed as specified in Paragraph 2.31 shall be examined under a 20 X microscope for cracking of the insulation. The presence of cracks in the insulation shall be considered as a failure of the insulation.

2.4 The insulated wire shall be tested for heat shock after the method specified in Paragraph 2.41 and the insulated wire shall meet the requirements specified in Paragraph 2.42.

2.41 Three test specimens shall be prepared in the manner specified in Paragraph 2.31 and heated to 260 degrees Fahrenheit and allowed to cool to room temperature (60 to 80 degrees Fahrenheit).

2.42 The specimen shall be examined after cooling with a 20 X microscope for cracking of the film. If any cracks are visible the insulation shall be considered to be unsatisfactory.

2.5 The insulation shall be tested for abrasion resistance by the scrape tester specified in Paragraph 2.51 and the insulation shall meet the requirements given in Paragraph 2.52.

2.51 The wire scrape-abrasion tester is composed of a scraper head holding a No. 11 (0.016") steel serving needle at right angles to the axis of the test wire (the side of

the needle rests on the wire); an anvil is provided to hold the specimen. The scraper head is arranged to press against the specimen with pressures ranging from 10 to 1200 grams in 10 gram steps. The scraper head shall have a travel of 3/8" working with a reciprocating motion at a rate of 60 times per minute. A revolution counter shall be used to count the number of strokes or cycles. An electrical failure detecting and shut-off device shall be used to stop the tester when the insulation film is worn through. (The G.E. Scrape Abrasion Tester, Cat. No. 512040391 meets these requirements.) Test shall be made at a temperature of about 68 degrees Fahrenheit.

2.52 The test specimens shall be two 6 inch lengths of wire from which kinks and bends have been removed by stretching the sample by one or two percent. The insulation shall be removed from one end of the test specimen for a length of 1/2" for electrical connection. The pressure exerted by the scraper head on the specimen is specified in the following table and depends on the diameter of the bare wire.

| Nominal bare wire diameter - inch | Total weight of scraper head - grams |
|---|---|
| .0285 | 580 |
| .0253 | 540 |
| .0226 | 500 |
| .0201 | 470 |
| .0179 | 440 |
| .0159 | 410 |
| .0142 | 380 |
| .0126 | 350 |
| .0113 | 330 |
| .0100 | 300 |

The scraper head shall be placed carefully on the test specimen and the tests started. When failure occurs, the number of scrapers to failure is recorded and the sample is rotated 120° and the test repeated. This makes three tests on each sample. No single test shall be less than 30 strokes for an insulation to be considered as satisfactory.

2.6 The insulation shall meet the solvent resistance requirements specified in Paragraph 2.62 when tested after the method outlined in Paragraph 2.61.

2.61 Five samples of the insulated wire each 8 inches long shall be annealed by baking in an oven for ten minutes at 260 degrees Fahrenheit. Each sample shall be placed in a 3/4 inch by 6 inch glass test tube. The test tubes shall be filled with the following solvents:

| | | |
|---|---|---|
| 1st Test Tube | - | Tulol |
| 2nd | do | 55° Naphtha |
| 3rd | do | No. 1 Denatured Alcohol |
| 4th | do | 5% Sulphuric Acid |
| 5th | do | 1% Potassium Hydroxide |

The samples shall soak in the solution for 24 hours at room temperature (about 68° Fahrenheit).

2.62 Each specimen shall be removed individually from the test tube and wiped once with a cheese cloth gripped firmly between the observer's thumb and forefinger. If any of the liquids have softened the film sufficiently to allow the insulation to be removed by the cheese cloth so as to expose the bare wire, the insulation is considered to be unsatisfactory.

2.7 The continuity of the insulation shall meet the requirements specified in Paragraph 2.72 when tested by the method described in Paragraph 2.71.

2.71 A 100 foot length of insulated wire shall be passed through a mercury bath at a depth of one inch below the surface of the mercury at a rate of two feet per minute. The conductor shall be one side of an electrical indicator circuit while the mercury bath shall be the other side of the circuit. A d.c. voltage shall be applied as shown in the following table.

| Nominal bare wire - diam. inch | Volts d.c. |
|---|---|
| .0285 - .0201 | 90 |
| .0179 - .0113 | 75 |
| .0100 - .0063 | 60 |
| .0056 - .0031 | 30 |
| .0030 - .0025 | 20 |

2.72 There shall not be more than 10 breaks in the insulation in the 100-foot length of insulated wire.

2.8 The insulation shall show no cracks when the sample has been baked in an oven for 168 hours at a temperature of 260 degrees Fahrenheit and allowed to cool at room temperature, then wrapped around a mandrel having a diameter three times the bare wire diameter.

3. ELECTRICAL PERFORMANCE

3.1 The dielectric strength of the insulation shall meet the specified requirements given in Paragraph 3.12 when tested in the manner specified in Paragraph 3.11.

3.11 Two pieces of the insulated wire shall be twisted together for a distance of approximately five inches. The test voltages listed in Paragraph 3.12 shall be applied to the two wires.

3.12 The insulation shall have dielectric strength as listed in the following table:

| Nominal bare wire diam. - inch | Volts a.c. |
|---|---|
| .0285 to .0201 | 3400 |
| .0179 to .0126 | 3000 |
| .0113 to .008 | 2200 |
| .0071 to .005 | 1600 |
| .0045 to .0031 | 1000 |
| .0028 to .0020 | 600 |
| .00175 to .0010 | 400 |

APPENDIX II

Specification for Voice Frequency Loading Coils
and Loading Coil Cases

1. GENERAL

1.1 Appendix II to the specification for Voice Frequency Loading Coils and Loading Coil Cases specifies the material to be used for moisture proofing impregnation and method of impregnating loading coils.

2. MATERIAL FOR MOISTURE PROOFING IMPREGNATION

2.1 The insulating material used for impregnating loading coils to give protection against moisture migration shall be a phenol-aldehyde type resin which under heat-induced chemical polymerization will completely solidify.

2.2 The material shall be of such consistancy that in liquid state it will penetrate to core of loading coil during impregnation process and will not form voids between windings of coil.

2.3 In cured condition the impregnating material shall not be affected by a 5% solution of caustic alkali, a 50% solution of sulfuric acid or a 50% solution of nitric acid.

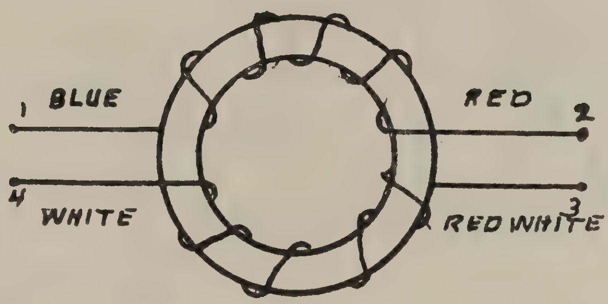
2.4 A suitable material for impregnation should have chemical and physical properties similar to the following:

| | |
|---|---|
| Type | Internal curing - baking |
| Composition | Phenol - aldehyde natural rosins |
| Solvent | Varnish makers and painters naphtha |
| Distillation Range | 220° F. to 300° F. |
| Percent Solids | 55 to 60% |
| Baume at | 30° C. of 31° |
| Specific Gravity at | 30° C. of .869 |
| Viscosity at | 30° C. of 50 to 60 seconds - Demmler #1 (Westinghouse Viscosity Cup) |
| Flash Point | Open cup 56° F. |
| Dielectric Strength | 2500 to 2700 volts per mil |

3. METHOD OF IMPREGNATION

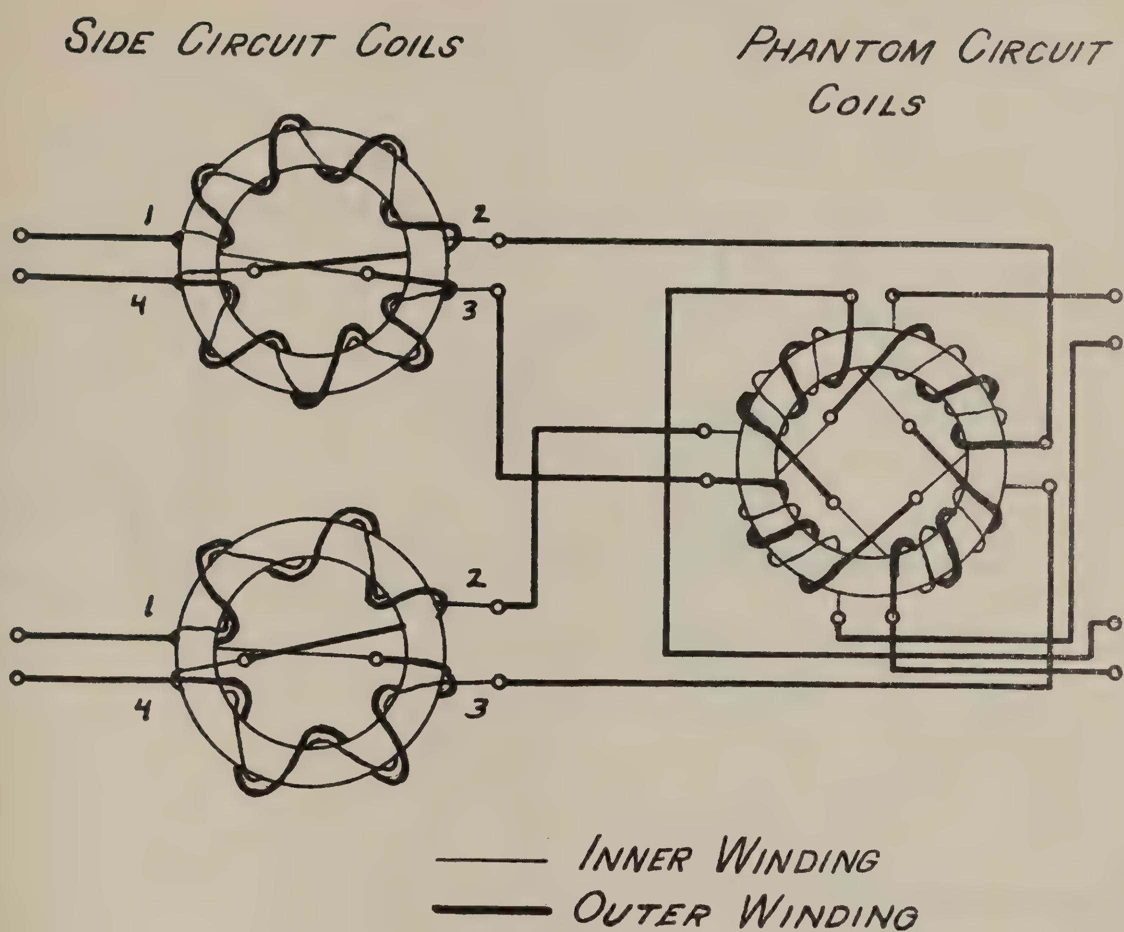
3.1 The loading coils shall be impregnated with material specified in Paragraphs 2 to 2.4 of this appendix after the method described in the following processing schedule:

1. Preheat the loading coils for 60 minutes at a temperature of 250 degrees Fahrenheit minus 0 to plus 10 degree.
2. Place the preheated loading coils in a vacuum chamber directly after the preheating step and evacuate for 45 minutes at vacuum of approximately 28 inches of mercury.
3. Break the vacuum by introducing the impregnating insulation materials at a viscosity of approximately 45 to 50 seconds at 30 degrees centigrado as measured with a Demmler #1 cup.
4. Allow the loading coils to remain submerged for approximately 45 minutes. If additional pressure is found necessary to obtain complete penetration, use $CO_2$ gas.
5. Remove loading coils from impregnating material and allow to drain for approximately 15 minutes.
6. Bake the impregnated loading coils for five hours at a temperature of 250 degrees to 275 degrees Fahrenheit.
7. Flash dip (flash dip means dipping the loading coils into the impregnating material and immediately withdrawing.)
8. Drain for 10 minutes.
9. Bake for 5 hours at a temperature of 250 degrees to 275 degrees Fahrenheit.



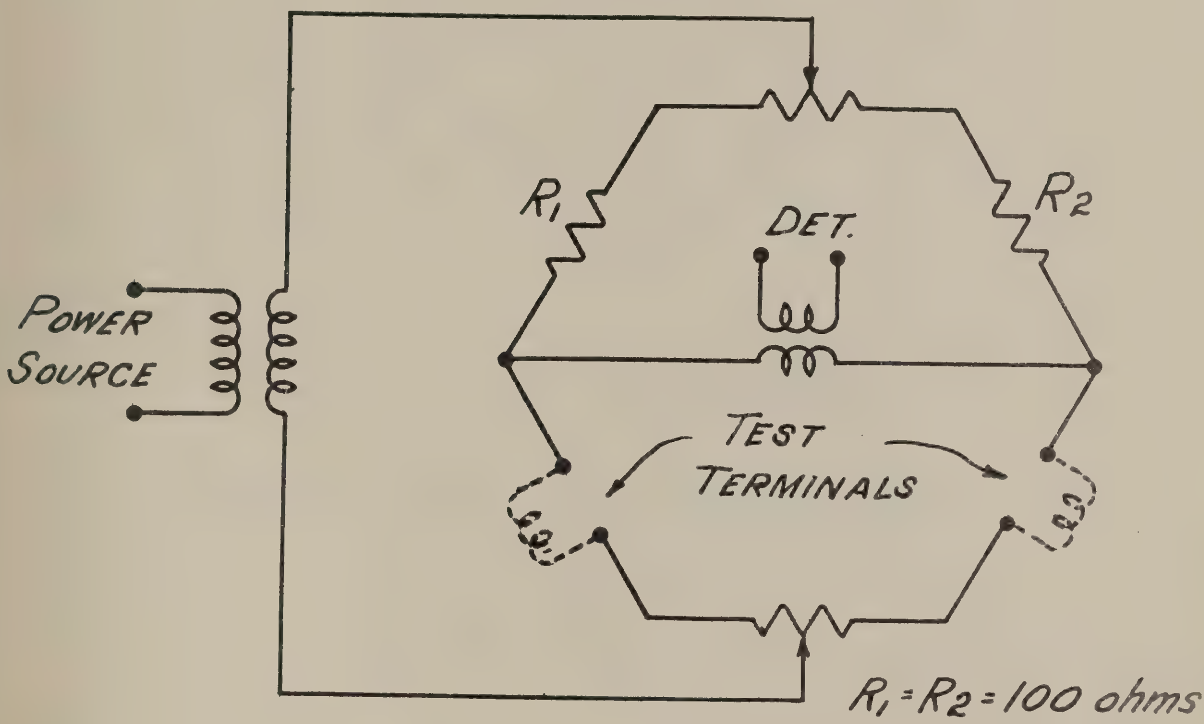

WIRING DIAGRAM FOR 32, 38 AND 51
LOADING COIL UNIT

FIG. 1

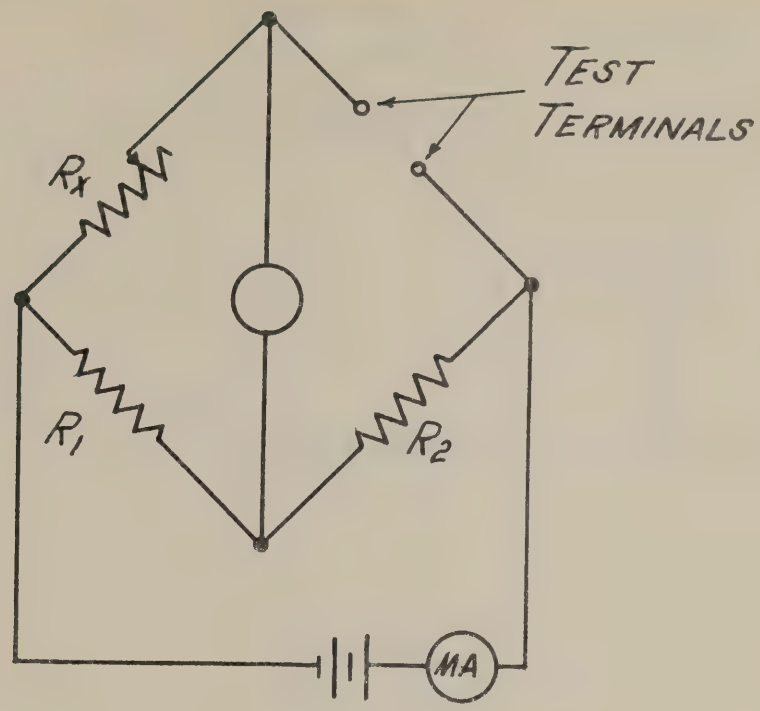



WIRING DIAGRAM FOR 88-50 PHANTOM LOADING COIL UNIT

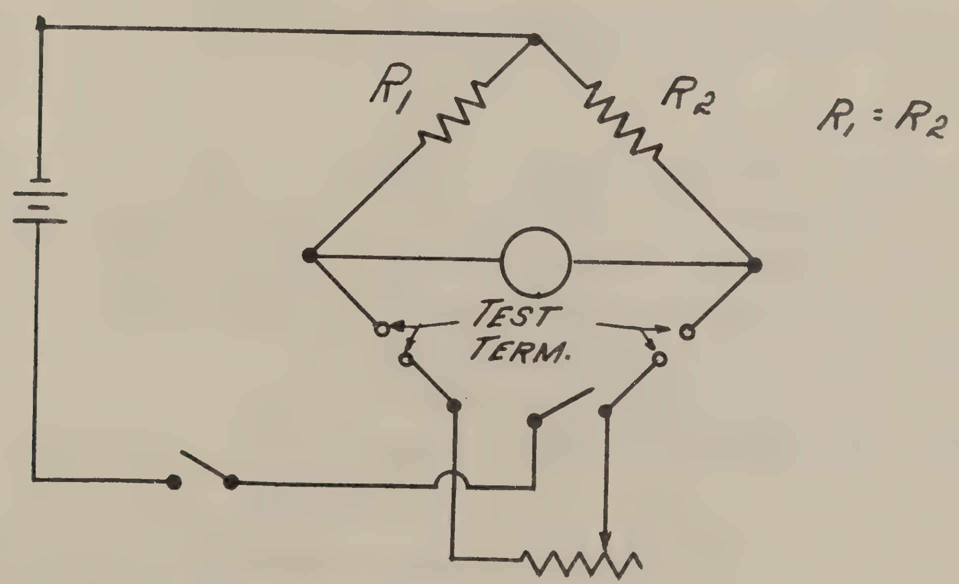
FIG. 2



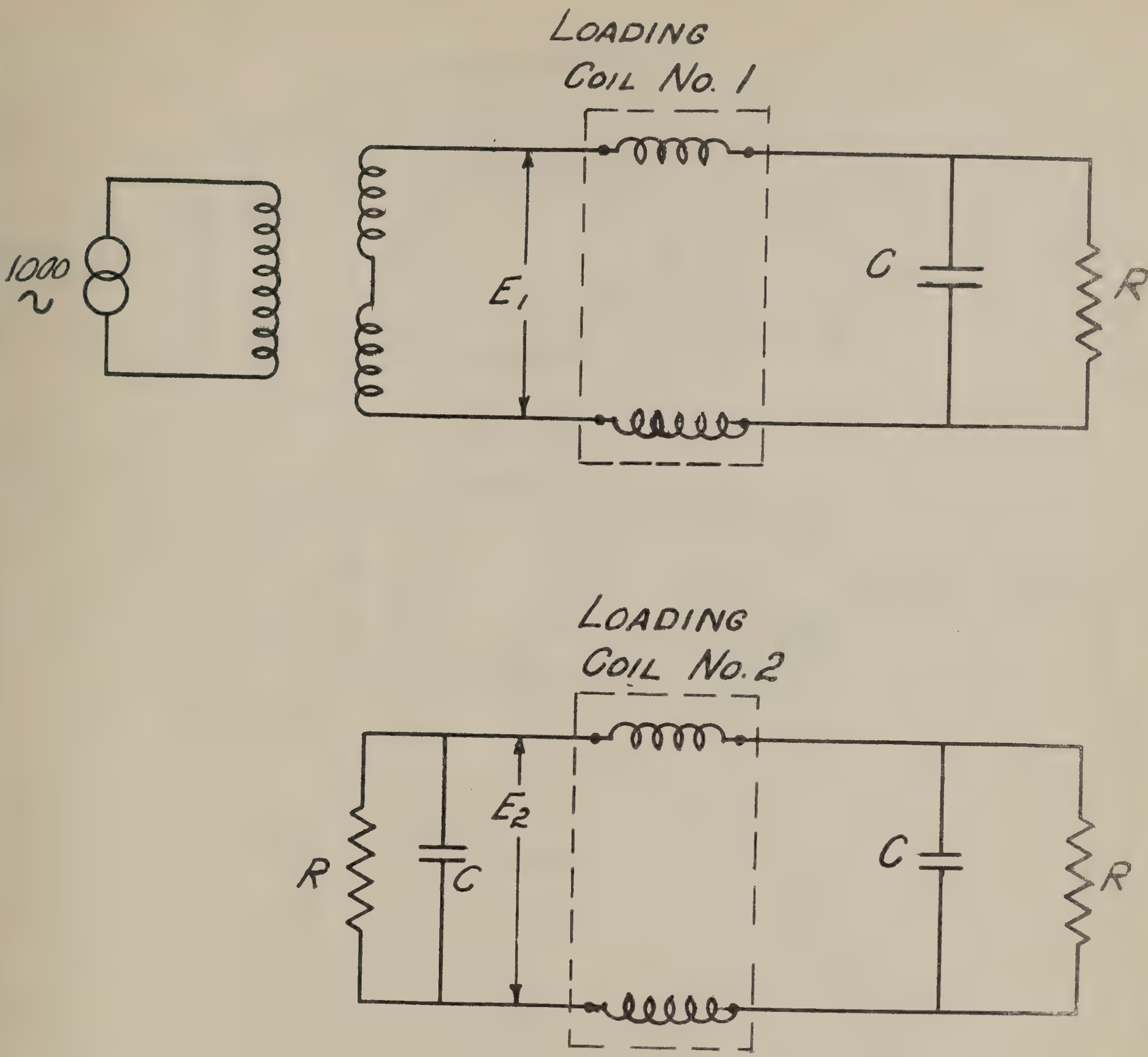

INDUCTANCE UNBALANCE CIRCUIT
FIG. 3




LOADING COIL D.C. RESISTANCE
TEST CIRCUIT
FIG. 4.




D.C. RESISTANCE UNBALANCE
TEST CIRCUIT
FIG. 5.



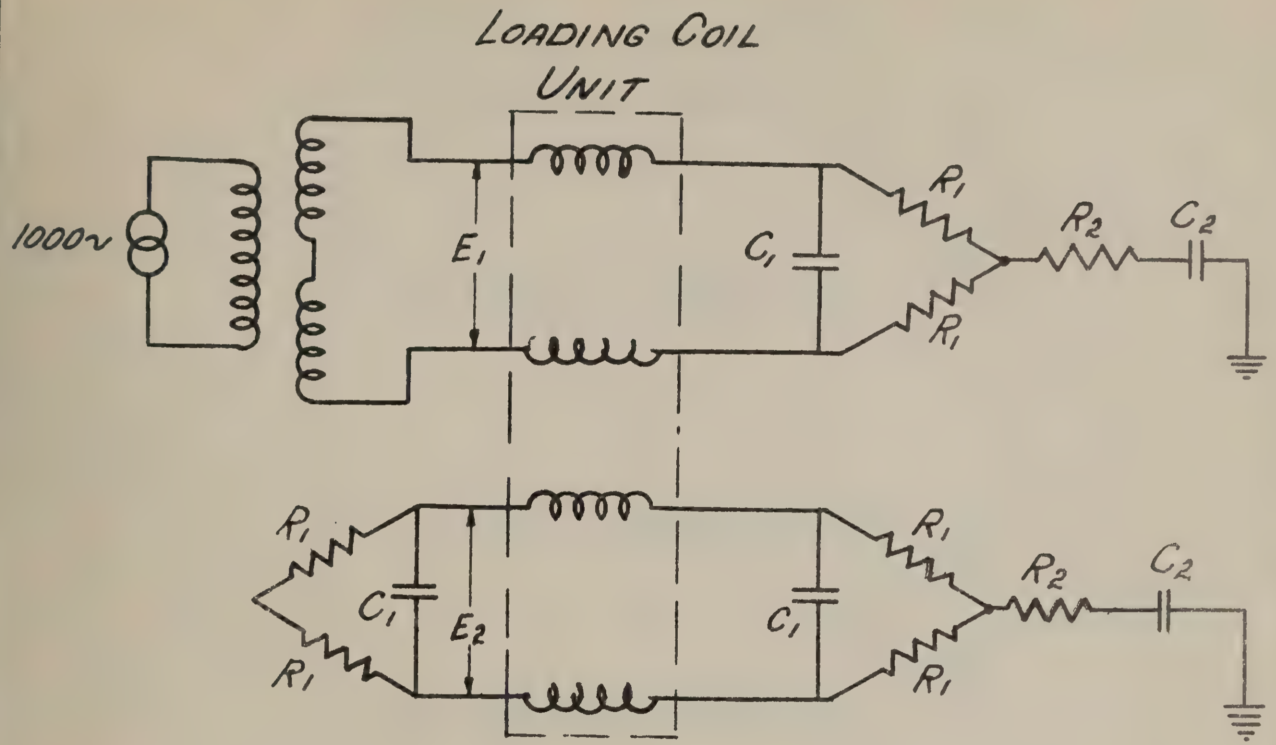

| | C | R |
|---|---|---|
| H88 | .061 mfd | 1200 ohms |
| H44 | .09 mfd | 870 ohms |

Note: When crosstalk is measured between coils not mounted in loading coil case, coils No. 1 and No. 2 shall be separated 1/8" by a non-magnetic spacer. The coils shall be pressed firmly against the spacer with non-magnetic brackets.

FIG. 6

CIRCUIT FOR

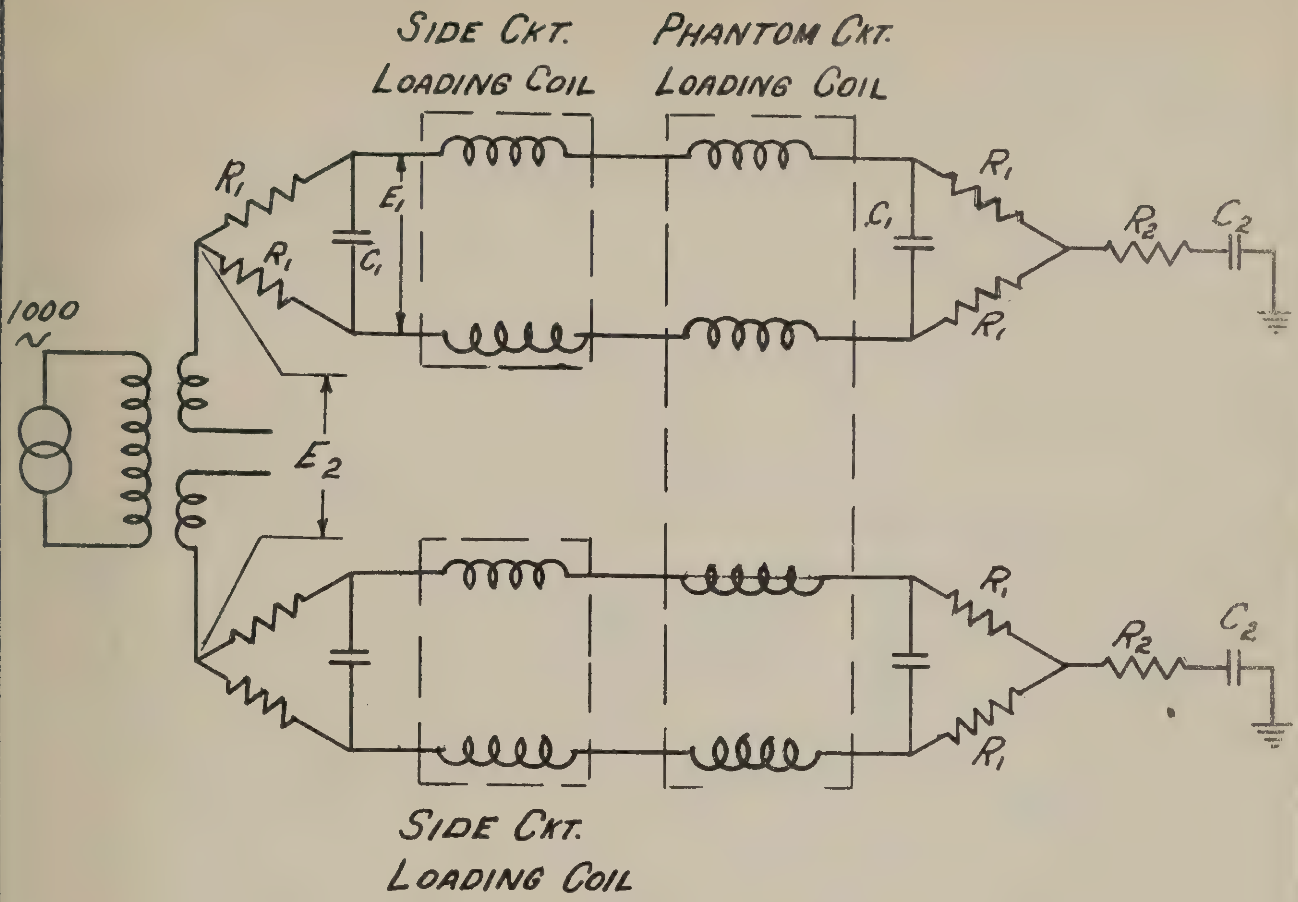
CROSSTALK MEASUREMENT BETWEEN TWO SUBSCRIBER LINE LOADING COILS




$R_1$ = 575 ohms
$C_1$ = .047 mfd
$R_2$ = 28 ohms
$C_2$ = 1.6 mfd

CIRCUIT FOR CROSS TALK MEASUREMENT BETWEEN SIDE CIRCUITS OF A PHANTOM GROUP 88-50.

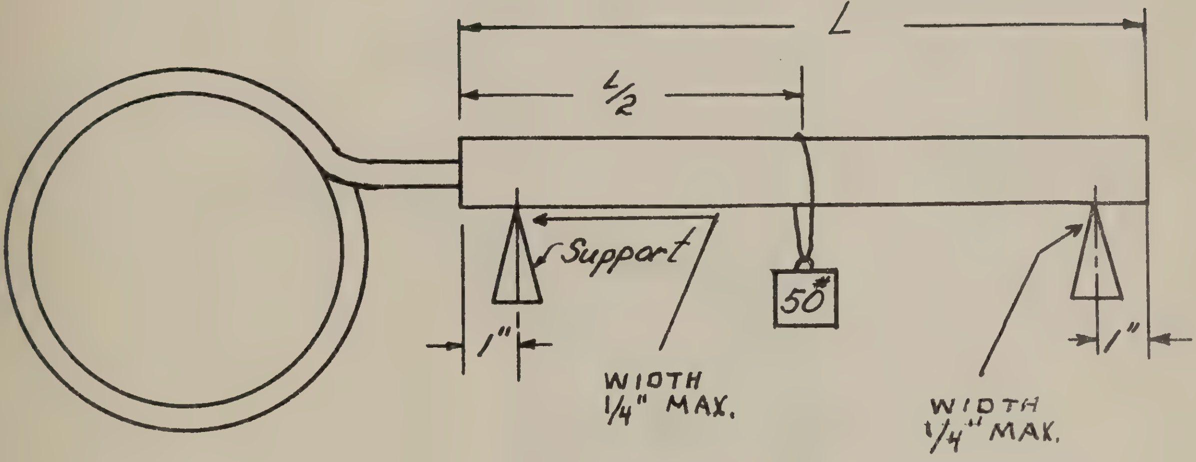
FIG. 7




$C_1$ = .049 mfd
$C_2$ = 1.7 mfd
$R_1$ = 612 ohms
$R_2$ = 24 ohms

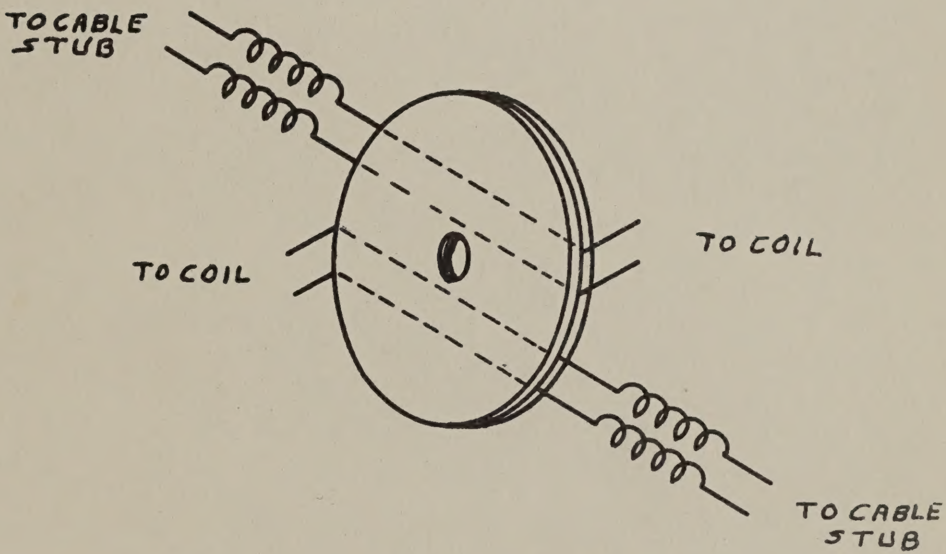
CIRCUIT FOR CROSS TALK MEASUREMENT BETWEEN PHANTOM CIRCUIT AND SIDE CIRCUIT

FIG. 8




METHOD OF CHECKING MECHANICAL STRENGTH
OF LOADING COIL CASE

FIG. 9




LEAD ANCHOR AND SEPARATOR FOR
LOADING COIL
FIG. 10